

**UNITED STATES AIR FORCE  
311<sup>th</sup> Human Systems Wing**

---

# **The Development of Empirically- based Medical Standards for Large and Weaponized Unmanned Aircraft System Pilots**

**Anthony P. Tvaryanas, Major, USAF**

**October 2006**

# **20061102014**

*Distribution A: Approved for public  
release; distribution unlimited.*

**311<sup>th</sup> Performance Enhancement Directorate  
Performance Enhancement Research Division  
2485 Gillingham Drive  
Brooks City-Base TX 78235-5105**

## NOTICES

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely Government-related procurement, the United States Government incurs no responsibility or any obligation whatsoever. The fact that the Government may have formulated or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication, or otherwise in any manner construed, as licensing the holder or any other person or corporation; or as conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

The mention of trade names or commercial products in this publication is for illustration purposes and does not constitute endorsement or recommendation for use by the United States Air Force.

The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.


This report has been reviewed and is approved for publication.

Government agencies and their contractors registered with Defense Technical Information Center (DTIC) should direct requests for copies to: Defense Technical Information Center, 8725 John J. Kingman Rd., STE 0944, Ft. Belvoir, VA 22060-6218.

Non-Government agencies may purchase copies of this report from: National Technical Information Services (NTIS), 5285 Port Royal Road, Springfield, VA 22161-2103.



ANTHONY P. TVARYANAS  
Maj, USAF, MC, FS  
Chief, Unmanned Aircraft System  
Human-Systems Integration Branch



STEFAN H. CONSTABLE  
Chief, Performance Enhancement Research  
Division

<b>REPORT DOCUMENTATION PAGE</b>			<i>Form Approved</i> <b>OMB No. 0704-0188</b>	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Service, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.				
<b>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</b>				
<b>1. REPORT DATE (DD-MM-YYYY)</b> 10-03-2006		<b>2. REPORT TYPE</b> Final		<b>3. DATES COVERED (From - To)</b> Dec 2005 - Oct 2006
<b>4. TITLE AND SUBTITLE</b> The Development of Empirically-based Medical Standards for Large and Weaponized Unmanned Aircraft System Pilots			<b>5a. CONTRACT NUMBER</b>	
			<b>5b. GRANT NUMBER</b>	
			<b>5c. PROGRAM ELEMENT NUMBER</b>	
<b>6. AUTHOR(S)</b> Tvaryanas, Anthony P.			<b>5d. PROJECT NUMBER</b>	
			<b>5e. TASK NUMBER</b>	
			<b>5f. WORK UNIT NUMBER</b>	
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> 311 <sup>th</sup> Performance Enhancement Directorate 2485 Gillingham Drive Brooks City-Base, TX 78235-5105			<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>  HSW-PE-BR-TR-2006-0004	
<b>9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b>			<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b>	
			<b>11. SPONSORING/MONITORING AGENCY REPORT NUMBER</b>	
<b>12. DISTRIBUTION AVAILABILITY STATEMENT</b> Distribution statement A: Approved for public release; distribution unlimited.				
<b>13. SUPPLEMENTARY NOTES</b>				
<b>14. ABSTRACT</b> Background: This study was undertaken to establish recommendations for aeromedical certification standards for pilots controlling either large or weaponized unmanned aircraft systems (UASs). Methods: This study employed a task analysis of MQ-1 Predator and MQ-9 Reaper UAS pilots to establish the type of work performed by UAS pilots and the contextual work conditions. Subsequently, a panel of aerospace medicine subject matter experts at the USAF's Aeromedical Consultation Service (USAFSAM/FEC) representing various subdisciplines of medicine developed recommendations for UAS pilot medical standards. Issues considered by the panel included the physical demands of the present and anticipated future ground control station environments and the likelihood for medical conditions to predispose to incapacitation or cause undue distraction or performance degradation. Results: The recommended medical standards differed significantly for current medical standards for ground-based controller duty and for flying duty. Conclusion: A separate set of medical standards should be created for career UAS pilots flying large or weaponized UASs.				
<b>15. SUBJECT TERMS</b> Unmanned aerial vehicles, Uninhabited aerial vehicles, Remotely piloted aircraft, Remotely piloted vehicles, Pilot medical standards.				
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b> UL	
a. REPORT UNCLASSIFIED	b. ABSTRACT UNCLASSIFIED	c. THIS PAGE UNCLASSIFIED	<b>18. NUMBER OF PAGES</b> 36	
			<b>19a. NAME OF RESPONSIBLE PERSON</b> Maj Anthony P. Tvaryanas	
			<b>19b. TELEPHONE NUMBER (Include area code)</b> 210-536-4446; DSN 240-4446	

**THIS PAGE INTENTIONALLY LEFT BLANK**

## TABLE OF CONTENTS

	Page
LIST OF FIGURES .....	iv
LIST OF TABLES.....	v
EXECUTIVE SUMMARY .....	vi
ACKNOWLEDGEMENTS.....	vii
INTRODUCTION .....	1
METHODS .....	3
Task Analysis .....	3
Medical Standards .....	4
RESULTS .....	4
Task Analysis .....	4
Medical Standards .....	6
CONCLUSION .....	17
REFERENCES .....	20
APPENDIX A - UAS DESCRIPTIONS .....	21
APPENDIX B - ACRONYMS .....	23

## LIST OF FIGURES

	Page
Figure 1. Notional initial training pipeline for new UAS pilot career path.....	2
Figure 2. NATO STANAG 4586 levels of UAS interoperability. ....	18
Figure 3. Notional graph showing the trend for sensor operator duties to encroach upon pilot tasks as their mission participation and responsibilities increase in the multi-aircraft control (MAC) environment. ....	19

## LIST OF TABLES

Page

TABLE 1. Predator UAS pilot major accomplishments and associated tasks. ....	5
--	---

## EXECUTIVE SUMMARY

This report describes the results of a study conducted at the request of AF/A3OT. The study was initiated to examine questions raised regarding medical standards for officers selected to enter a new rated career path as pilots of large (e.g., the size of a MQ-1 Predator aircraft or greater) or weaponized unmanned aircraft systems (UASs). Present plans call for UAS pilot applicants to complete a limited period of manned aircraft flight training early in their training pipeline. Subsequently, there will not be any further manned aircraft flying, nor will UAS pilots be eligible for unmanned-to-manned aviation cross-flow. Existing medical standards are applicable for the initial period of manned aircraft flight training: Federal Aviation Administration third class medical standards or AFI48-123V3 Attachment 4 flying class I medical standards depending on whether training occurs at a civil or military facility. Nevertheless, questions remained whether AFI48-123V3 Attachment 4 flying class I and II medical standards are warranted for *initial certification* of those with prior flight experience directly admitted into undergraduate remotely piloted aircraft training (URT) or for *continuing certification* of UAS pilots during their subsequent unmanned aviation flying careers.

This study employed a task analysis of MQ-1 Predator and MQ-9 Reaper UAS pilots assigned to the 11<sup>th</sup>, 15<sup>th</sup>, and 17<sup>th</sup> Reconnaissance Squadrons to establish the type of work performed by UAS pilots and the contextual work conditions (e.g., ground control station (GCS) human-machine interface, operational tempo, shift work, etc.). Subsequently, a panel of aerospace medicine subject matter experts at the USAF's Aeromedical Consultation Service (USAFSAM/FEC) representing various subdisciplines of medicine developed recommendations for UAS pilot medical standards. A baseline assumption was made that all UAS pilots must meet medical standards for military service in accordance with AFI48-123V2 Attachment 2. Issues considered by the panel in recommending medical standards included:

- Physical demands of the present GCS task environment as well as consideration of how near-term technological advances may modify that task environment (e.g., 3D synthetic vision, etc.).
- Likelihood of a medical condition to predispose to sudden incapacitation.
- Likelihood of a medical condition to cause undue distraction, potentially degrade performance, or both.

The resulting recommended standards differed significantly from current medical standards for ground-based controller duty (e.g., AFI48-123V3 Attachment 2) and for flying duty (AFI48-123V3 Attachment 4). In particular, ground-based controller duty standards lacked sufficient rigor to address many of concerns associated with current UAS operations while flying duty standards were unnecessarily restrictive. Therefore, it is recommended a separate set of medical standards be created for career UAS pilots flying large or weaponized UASs.



## ACKNOWLEDGEMENTS

The author expresses thanks to the 57th Wing MQ-1 Predator squadrons at Nellis and Creech Air Force Bases whose time and cooperation were crucial to acquiring the task analysis data underlying the recommendations documented in this report. The author would also like to acknowledge the contributions of the Survivability and Vulnerability Analysis Center (SURVIAC) Front End Analysis team for their work in conducting the task analysis as well as the aerospace medicine specialists at the U.S. Air Force's Aeromedical Consultation Service for their work in drafting the recommended medical standards. The views and opinions are those of the author and do not necessarily represent the views of the U.S. Air Force, the Department of Defense, or any other government agency.

# **THE DEVELOPMENT OF EMPIRICALLY-BASED MEDICAL STANDARDS FOR LARGE AND WEAPONIZED UNMANNED AIRCRAFT SYSTEM PILOTS**

## **INTRODUCTION**

This study was undertaken to establish recommendations for aeromedical certification standards for pilots controlling either large (e.g., the size of a MQ-1 Predator aircraft or greater) or weaponized unmanned aircraft. Within the U.S. Air Force (USAF), such unmanned aircraft systems (UASs) currently include the MQ-1 Predator, MQ-9 Reaper, and RQ-4 Global Hawk. These UASs are controlled mainly by rated USAF pilots although a small number of USAF navigators with a Federal Aviation Administration (FAA) commercial license with instrument rating are also utilized. Pilots must be qualified for flying duties in accordance with (IAW) Air Force Instruction (AFI) 48-123V3 Attachment 4 flying class II medical standards. Pilots with medical conditions incompatible with traditional manned aviation duties may receive waivers restricting them to unmanned aviation duties. Pilots of small, non-weaponized UASs and sensor operators must meet AFI48-123V3 Attachment 2 ground-based controller medical standards.

Since the vast majority of pilots selected for UAS duty serve only one assignment in unmanned aviation and then return to manned aviation, it is logical to require them to continue to meet flying class II medical standards. However, the USAF is in the process of creating a separate career path for UAS pilots. Individuals entering this new career path will be considered rated officers and will have a distinct Air Force Specialty Code (AFSC) (e.g., 17xx). Although the specifics of the initial training are still being developed, the basic notional pipeline is illustrated in figure 1. At present, there is no data on the question of whether learning that occurs during manned aircraft flight training could not be adequately addressed during training with unmanned aircraft. In the interim, the USAF has decided manned aircraft training is necessary and will be accomplished during the Initial Flight Screening (IFS) block (figure 1-A). The length and format of training during IFS has yet to be definitively decided, but it will likely involve instruction either in a civil environment using a single-engine general aviation type aircraft or in a military environment using the T-6A Texan II aircraft. There will be no manned aircraft flying after IFS, with all further training being accomplished using simulators or unmanned aircraft (figure 1-B). Additionally, UAS pilots will be ineligible for future assignments as pilots of manned aircraft (e.g., no unmanned-to-manned aviation cross-flow).

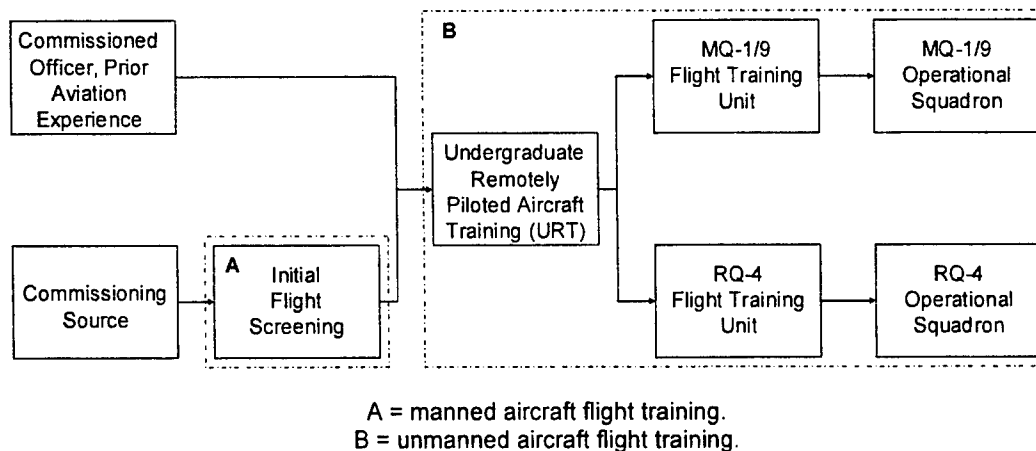


Figure 1. Notional initial training pipeline for new UAS pilot career path.

AF/A3OT raised the question in February 2006 as to the most appropriate medical standards for this new UAS pilot career path. Existing medical standards are applicable to IFS depending on the choice of training environment. If a civil training environment is chosen, initial applicants will need to possess a FAA student-pilot certificate and thus meet FAA third class medical standards. If a military training environment is chosen instead, applicants will need to comply with the flying class I medical standards IAW AFI48-123V3 Attachment 4. Alternatively, if current policies were amended, another option would be for initial applicants to meet the less rigorous flying class II or even class III standards given the short time period they will be participating in manned aviation flying. Nevertheless, questions remained whether AFI48-123V3 Attachment 4 flying class I and II medical standards are warranted after IFS, either for *initial certification* of those with prior flight experience directly admitted into undergraduate remotely piloted aircraft training (URT) or for *continuing certification* of UAS pilots during their subsequent unmanned aviation flying careers.

The issue of medical standards for individuals participating solely in unmanned aviation is a hotly debated topic. There currently are no uniform standards across the military services (Weeks, 2000) nor are there formal civil standards for the aeromedical certification of UAS pilots (Williams, 2005). While various organizations are developing recommendations for standards (American Society for Testing and Materials subcommittee F-38.03; National Aeronautics and Space Administration's Access 5 program (inactive); RTCA, Incorporated special committee 203; and SAE International's G-10 Aerospace Behavioral Engineering Technology Committee), there have been few studies (Biggerstaff, Blower, Portman, & Chapman, 1998) addressing medical standards based on an empirical analysis of the UAS pilot task environment. One of the unique attributes of UASs is that the aircrew and their aircraft are no longer necessarily co-located. From an occupational medicine perspective, UASs are therefore the engineering control for such traditional aeromedical physical hazards as hypobarics, hypoxia, acceleration, vibration, thermal stress, and those forms of spatial disorientation associated with acceleration (Tvaryanas, in press). This has led some to argue that controlling one or more UAs is more akin to air traffic control and thus medical standards for ground-based

controller duty are appropriate. This argument misses the critical distinction that UAS operations involve much more than simply monitoring and controlling one or more aircraft. Others, such as the FAA, believe existing manned flying medical standards (e.g., FAA second class medical standards) are appropriate for unmanned aviation (N. Lomangino, personal communication, March 16, 2005). However, UAS operations are not the same as manned aviation because the pilot is remote and has access to only a subset of the environmental cues available to a pilot of a manned aircraft (Cooke, 2006).

This study was undertaken to establish medical standards for pilots involved solely in unmanned aviation based on an empirical analysis of the UAS task environment. Unlike in manned aircraft where the task environment is dictated by aircraft design, the task environment in unmanned aviation is largely dependent on the design of the ground control station (GCS) and relatively independent of the design of the aircraft. In some cases, the same GCS can be used to control a spectrum of unmanned aircraft either individually or simultaneously. Additionally, the level of automation employed in a UAS can substantially modify the prerequisite knowledge, skills, and abilities demanded of the pilot as well as the risk for adverse outcomes in the case of pilot incapacitation. Compounding these issues is the lack of a generally accepted method for classifying UASs based on GCS design or level of automation. For these reasons, the focus of this study was limited to the MQ-1 Predator and MQ-9 Reaper UASs as they utilize a lower level of autonomy and have a more physically demanding human machine interface than the RQ-4 Global Hawk UAS. In short, medical standards designed for MQ-1 Predator and MQ-9 Reaper UAS pilots were felt to be sufficient, if not somewhat overly constraining, for pilots of other current or anticipated large or weaponized USAF UASs.

## **METHODS**

### **Task Analysis**

The use of a proven human performance model is essential to the objective analysis of human performance. For this study, a New Performance Planning Front End Analysis (NPP FEA) methodology was selected to analyze Predator UAS pilot performance. The NPP FEA is the preferred method when new job accomplishments must be produced due to the creation of new job assignments, assumption of additional responsibilities, or introduction of new technology in the workplace. Such issues are applicable to the job of UAS pilot, particularly with the proposed development of the new 17xx career field. The main steps of a NPP FEA include determining major job accomplishments (MAs), collecting data on these MAs, identifying the associated tasks producing these MAs, and collecting data on these tasks.

The Predator UAS pilot performance analysis was accomplished by the 311<sup>th</sup> Performance Enhancement Directorate under the auspices of the Survivability and Vulnerability Information Analysis Center (SURVIAC) Technical Area Task 05-41. The analysis approach consisted of four phases. During the first phase, the analysis team reviewed Defense Technical Information Center (DTIC) literature, government furnished information, and publications and technical data related to Predator UAS operations. Based on this information, the team

developed notional lists of MAs. During phase two, the team interviewed Predator UAS subject matter experts (SMEs) to identify and validate organizational goals and objectives for linkage to MAs. Phase three consisted of site visits to UAS squadrons (11<sup>th</sup> Reconnaissance Squadron (RS), 15 RS, and 17 RS) for further SME interviews as well as to observe and interview Predator and Reaper UAS pilots using the NPP FEA job aids. The final phase consisted of data reduction and report production.

### **Medical Standards**

A panel of aerospace medicine SMEs at the USAF's Aeromedical Consultation Service (USAFSAM/FEC) representing various subdisciplines of medicine (e.g., internal medicine, occupational medicine, ophthalmology, and neuropsychiatry) developed recommendations for UAS pilot medical standards. First, a baseline assumption was made that all UAS pilots must meet medical standards for military service IAW AFI48-123V2 Attachment 2. Second, the type of work being performed and contextual work conditions (e.g., GCS human-machine interface, operational tempo, shift work, etc.) were established based on the results of the NPP FEA. Third, using medical standards for ground-based controllers (AFI48-123V3 Attachment 2) as a starting point for discussion, UAS pilot medical standards were developed through a consensus of the panel members. Issues considered by the panel in recommending medical standards included:

- Physical demands of the present GCS task environment as well as consideration of how near-term technological advances may modify that task environment (e.g., 3D synthetic vision, etc.).
- Likelihood of a medical condition to predispose to sudden incapacitation.
- Likelihood of a medical condition to cause undue distraction, potentially degrade performance, or both.

## **RESULTS**

### **Task Analysis**

The detailed results of the NPP FEA are available upon request from the author. In short, the job of a Predator or Reaper UAS pilot involves 7 major accomplishments and 29 associated tasks (Table 1), which in turn can be further resolved into subtasks (not shown). Numerous differences were observed between the manned and unmanned aviation task environments. For example, there are very different ergonomic concerns and constraints in a traditional dynamic cockpit vice the static GCS. UAS pilots do not have integration concerns with life support equipment nor are they exposed to the hazards of the flight environment to include acceleration, vibration, hypoxia, and hypobarics. However, UAS pilots are relatively sensory deprived, lacking peripheral visual, auditory, and haptic cueing. They are nearly entirely dependent on focal vision in order to obtain information on aircraft state through automation and displays. Contrary to popular opinion, the UAS pilot isn't automated out of the loop with system success resting in the hands of the automation. UAS pilots perform safety sensitive duties as pilot incapacitation can directly lead to loss of aircraft control or indirectly create a hazard to other

aircraft as well as people and property on the ground because of an unattended aircraft. Additionally, the demands of indefinite around-the-clock operations create both a physically and physiologically demanding work environment. Daily teleoperation from home station to a combat zone has created unique psychological stressors as well. Overall, UAS pilots are engaged in all aspects of USAF operations. They have leadership responsibilities commensurate with their rank as USAF officers, are performing equivalent duties to that of rated manned aircrew, and are functioning as credentialed warriors.

TABLE 1. Predator UAS pilot major accomplishments and associated tasks.

Major accomplishments	Associated tasks
UA launched (launch by LRE and handover to MCE)	Perform mission planning Complete losing handover checklist (LRE) Complete gaining handover checklist (MCE)
Changeover (exchange of control between crews in the same GCS)	Perform mission planning (on-coming crew) Complete changeover (both crews) Complete post-flight tasks (off-going crew)
UA enroute (normal transition between operational areas)	Navigate to mission start point Perform fence check procedures
Reconnaissance (planned or reactionary)	Implement approach to gather requested EEI Position UA to collect EEI Divert to another mission
UA recovered	Complete losing handover checklist (MCE) Complete gaining handover checklist (LRE) Recover UA (approach and landing) Complete post-flight procedures
Strike	Gather target development information Implement airspace deconfliction plan Perform weaponeering Perform weapon pre-launch checklist Develop tactical plan Pass engagement information in sequence Conduct crew brief Perform weapon launch checklist Perform talk-on(s) Perform battle and collateral damage assessments
Operation after emergency or other hazard	Complete approved procedures Perform operational risk management Return to base (before or after completing mission) Ditch the UA (before or after completing mission)
EEI – essential elements of information, GCS – ground control station, LRE – launch and recovery element, MCE – mission control element, UA – unmanned aircraft	

## **Medical Standards**

Conditions listed in AFI48-123V2 Attachment 2, Medical Standards for Continued Military Service apply. For conditions listed in AFI48-123V2 Attachment 2, ensure a Medical Evaluation Board has been performed and final disposition made prior to submission of a waiver request. When a crewmember receives care by a non-flight surgeon provider, the member should be seen immediately by a flight surgeon for appropriate aeromedical disposition. If a flight surgeon is not immediately available, the member will be removed from UAS duties until seen by a flight surgeon or the visit reviewed by a flight surgeon.

**Applicability:** The standards in this attachment apply to operators of large or weaponized unmanned aircraft systems (UASs).

**UAS pilot disqualifying medical conditions:**

### **1.0. Ear, Nose, and Throat.**

- 1.1. Any disease or malformation of the nose, mouth, pharynx or larynx that might interfere with enunciation or clear voice communication.
- 1.2. Obstruction of the nose for any cause which prevents nasal respiration.

### **2.0. Hearing.**

- 2.1. A hearing profile greater than H-2 (refer to AFI48-123V4 Attachment 3 for hearing profile definitions).
  - 2.1.1. Although an H-2 profile does not require a waiver, an evaluation sufficient to rule-out conductive or retrocochlear pathology should be conducted to include a full audiological evaluation, and where appropriate, referral for otolaryngological consultation.
- 2.2. For crewmembers with new H-3 profiles (e.g., those whose hearing has recently changed to H-3 and who have not been previously evaluated), restriction from UAS duties is appropriate. An interim waiver may be granted by MAJCOM/SG after determination of acceptable hearing proficiency (e.g., occupational hearing assessment), pending complete audiological evaluation.

**NOTE:** Crewmembers with long-standing, stable H-3 profiles not previously evaluated by an audiologist, otolaryngologist, or both require work-up and waiver, but need not be restricted from UAS duties, unless in the opinion of the flight surgeon they represent a danger to flight safety.

- 2.3. For crewmembers actively engaged in UAS duties, validate hearing proficiency in one of two ways prior to issuance of a medical waiver for H-3 profile:
  - 2.3.1. A functional hearing assessment in the ground control station environment using the procedures described in AFPAM48-133 Section 7.8 and AFPAM48-133 Attachment 5. If the crewmember could potentially perform duties in a multi-aircraft control ground station, the hearing assessment should be conducted in this environment.

2.3.2. Written validation, signed by the flying squadron commander or operations officer, of the adequacy of the member's hearing to perform safely in assigned UAS duties in the ground control station environment. This validation should be supplemented by the assigned flight surgeon's written memorandum for record stating that speech discrimination levels, according to the audiologist's examination, are adequate for the performance of UAS duties.

2.4. Asymmetric hearing loss (as evidenced by a 25 decibel (dB) or greater difference between the left and right ears at any two consecutive frequencies) requires full audiological work-up with further clinical evaluation as indicated, and requires a waiver (indefinite waivers are not authorized). Restriction from UAS duties is not required during work-up.

2.5. The following tests are suggested as a complete audiological evaluation:

2.5.1. Pure tone air and bone conduction thresholds.

2.5.2. Speech reception thresholds.

2.5.3. Speech discrimination testing, to include high intensity discrimination.

2.5.4. Immittance audiometry.

2.5.5. Tympanograms.

2.5.6. Ipsilateral and contralateral acoustic reflexes (levels not exceeding 110 dB hearing level (HL)).

2.5.7. Acoustic reflex decay (500 and 1000 Hertz (Hz), with levels not exceeding 110 dB HL).

2.5.8. Otoacoustic emissions (transient evoked or distortion product).

2.6. The following tests may be required if indicated by those listed above.

2.6.1. Auditory brainstem response.

2.6.2. Magnetic resonance imaging (MRI).

### **3.0. Eye.**

3.1. Lids/adnexa. Any condition of the eyelids which impairs normal eyelid function or comfort, or potentially threatens visual performance, including, but not limited to epiphora, inflammation or obstruction of the nasolacrimal apparatus, and ptosis.

3.2. Conjunctiva.

3.2.1. Current conjunctivitis, including, but not limited to trachoma and chronic allergic conjunctivitis.

3.2.2. Xerophthalmia.

3.2.3. Pterygium if condition encroaches on the cornea in excess of 1 mm, interferes with vision, or is a progressive peripheral pterygium as evidenced by marked vascularity on a thickened, elevated head.

3.3. Cornea.



- 3.3.1. Current or history of keratitis, including, but not limited to recurrent corneal ulcers or corneal erosions.
- 3.3.2. Vascularization or opacification of the cornea for any cause which is progressive or reduces vision below standards.
- 3.3.3. Corneal dystrophy of any type to include keratoconus of any degree.
- 3.4. Uveal tract. Acute, chronic, or recurrent inflammation of the uveal tract (iris, ciliary body, or choroid) except for healed traumatic iritis.
- 3.5. Lens.
  - 3.5.1. Current aphakia, history of pseudophakia, or current or history of dislocation of a lens.
  - 3.5.2. Opacities, cataracts, or irregularities of the lens, which interfere with vision or are considered to be progressive.
- 3.6. Retina.
  - 3.6.1. Current or history of retinal defects and dystrophies, angiomas, retinoschisis and retinal cysts, phakomas, and other congenito-retinal hereditary conditions that impair visual function or are progressive.
  - 3.6.2. Current or history of any chorioretinal or retinal inflammatory conditions.
  - 3.6.3. Current or history of degenerative changes to any part of the retina.
  - 3.6.4. Current or history of detachment of the retina, history of surgery for the same or peripheral retinal injury, defect, or degeneration that may cause retinal detachment.
  - 3.6.5. Current or history of hemorrhages, exudates, or other retinal vascular disturbances.
- 3.7. Optic nerve.
  - 3.7.1. Current or history of optic neuritis, including, but not limited to neuroretinitis, papillitis, and retrobulbar neuritis.
  - 3.7.2. Current or history of optic atrophy (primary or secondary) or cortical blindness.
  - 3.7.3. Current or history of papilledema.
  - 3.7.4. Optic nerve cupping greater than 0.4 or an asymmetry between the cups of greater than 0.2, unless proven to be physiologic after comprehensive evaluation by an eye care specialist. This evaluation should include local diurnal pressure checks and visual field testing.
  - 3.7.5. Current or history of optic neuropathy.
  - 3.7.6. Optic nerve head drusen.
- 3.8. Ocular motility.
  - 3.8.1. Current or history of diplopia in any field of gaze, either constant or intermittent.
  - 3.8.2. Nystagmus, except at versional end points.

- 3.8.3. Absence of conjugate alignment in any quadrant.
- 3.8.4. Current or history of extraocular muscle paralysis or paresis with loss of ocular motility in any direction.
- 3.8.5. History of extraocular muscle surgery or strabismus therapies.
- 3.8.6. Esophoria greater than 10 prism diopters at near or distance.
- 3.8.7. Exophoria greater than 6 prism diopters at near or distance.
- 3.8.8. Hyperphoria greater than 1.5 prism diopters at near or distance.
- 3.8.9. Heterophorias, including microtropias, at near or distance
- 3.8.10. Point of convergence greater than 100 mm.

3.9. Miscellaneous defects and diseases.

- 3.9.1. Monocularity.
- 3.9.2. Current severe asthenopia.
- 3.9.3. Current or history of increased intraocular pressure.
  - 3.9.3.1. Glaucoma as evidenced by intraocular pressure of 30 mm Hg or greater or the secondary changes in the optic disc or visual field associated with glaucoma.
  - 3.9.3.2. Ocular hypertension (preglaucoma) as evidenced by two or more intraocular pressure determinations of 22 mm Hg or greater but less than 30 mm Hg, or a difference of 4 mm Hg or greater between the two eyes.

**NOTE:** Abnormal pressures obtained by noncontact (air puff) tonometer of Schiotz must be verified by applanation.

- 3.9.4. Current loss of normal pupillary reflex or reactions to accommodation or light with the exception of physiological anisocoria.
- 3.9.5. Current or history of retained intraocular foreign body.
- 3.9.6. Any traumatic, organic, or congenital disorder of the eye or adnexa which threatens, or potentially threatens, to intermittently or permanently impair visual function.
- 3.10. History of refractive or other ocular surgery to include lasers of any type. Waivers may be considered for refractive surgery (refer to USAF Aviation Refractive Surgery Website at [http://www.brooks.af.mil/web/consult\\_service/opto\\_sect/crs.htm?](http://www.brooks.af.mil/web/consult_service/opto_sect/crs.htm?)).

**4.0. Vision.**

- 4.1. Corrected distant vision worse than 20/20 in each eye.
- 4.2. Corrected near vision worse than 20/20 in each eye.
- 4.3. Contact lenses that only correct near visual acuity, are bifocal or multifocal, or are fit with monovision techniques.

4.4. Optional wear of contact lenses is in accordance with the USAF Aircrew Soft Contact Lens Policy per AFI48-123V3 Attachment 7.1.1.3.

4.5. Crewmembers who wear corrective spectacles or contact lenses must carry a spare set of prescription spectacles on their person while performing UAS duties.

## **5.0. Color Vision.**

5.1. Initial selection. Color vision deficit or anomaly of any degree or type.

5.1.1. All initial applicants must pass definitive color vision testing. Definitive color testing consists of the following tests approved by AF/SG.

5.1.1.1. Pseudo-Isochromatic Plates (PIP) I (minimum passing score 10/14 OU tested monocularly).

5.1.1.2. PIP II (minimum passing score 9/10 OU tested monocularly).

5.1.1.3. PIP III (minimum passing score 9/10 OU tested monocularly).

5.1.1.4. F2 pass or fail.

5.2. Trained assets. Must possess normal color vision as demonstrated by passing approved Air Force color vision test(s). I.

5.2.1. Trained assets that fail the PIP I and were previously qualified for flying or UAS duties based on a history of passing either the Farnsworth Lantern Test (FALANT) and/or the Color Threshold Tester (CTT) require a waiver. A formal ophthalmologic evaluation must be accomplished to determine the type and degree of color vision defect. The crewmember will be limited to their current ground control station (GCS) unless a functional assessment has been devised for the new GCS.

5.3. Color vision screening done at base level must be performed monocularly under an approved and standardized illuminant (e.g., MacBeth easel lamp with a 100 watt bulb or a True Daylight AE lamp from Richmond Products). Five or more incorrect responses in either eye (including failure to make responses in the allowed time interval (no more than five seconds)) in reading the 14 test plates of one of the following PIP tests is considered a failure: Dvorine, the original version of the American Optical (excludes Richmond PIP version), or Ishihara. No other PIP versions, such as the Richmond PIP, Beck Engraving versions, or other tests for color vision are authorized. Test scores should be recorded as the number of correct/total number presented. The FALANT is not authorized. (Refer to USAF Waiver Guide Website at

[http://www.brooks.af.mil/web/consult\\_service/waiver%20guide/Ophthalmology/Color%20Vision%20Deficiencies.htm](http://www.brooks.af.mil/web/consult_service/waiver%20guide/Ophthalmology/Color%20Vision%20Deficiencies.htm))

## **6.0. Depth Perception.**

6.1. Failure of either of the following screening tests for distant depth perception with best-corrected visual acuity: Vision Test Apparatus (VTA-DP) or the Optec Vision Tester (OVT).

6.2. Crewmembers who fail depth perception testing and are not required to possess normal depth perception for the performance of their duties may receive a MAJCOM waiver for

depth perception. The macular examination and motility evaluation must include all the tests:

- 6.2.1. Ductions, versions, cover test and alternate cover test in primary and 6 cardinal positions of gaze.
- 6.2.2. American Optical Vectograph Stereopsis Test at 6 meters (four line version).
- 6.2.3. American Optical Suppression Test at 6 meters.
- 6.2.4. Randot or Titmus Stereopsis Test.
- 6.2.5. Red Lens Test.
- 6.2.6. Four Diopter Base out Prism Test at 6 meters.

**NOTE:** These tests are designed to identify and characterize motility/alignment disorders, especially microtropias and monofixation syndrome. The results of these tests done locally are considered to be preliminary, but will be used by waiver authorities to determine whether a member should be permanently disqualified without any waiver consideration, to identify if there are easily correctable causes (e.g., spectacles), and to determine whether further evaluation is required.

#### **7.0. Visual Fields.**

- 7.1. Visual field defects of any type.
- 7.2. Central scotoma, whether active or inactive, including transitory migraine-related or any other central scotoma due to an active pathological process.
- 7.3. Any peripheral scotoma other than physiologic.

#### **8.0. Red Lens Test.**

- 8.1. Not required for trained assets. For initial selection, any diplopia or suppression during the Red Lens Test developing within 20 inches of the center of the screen (30 degrees) is considered a failure. If failed, a complete preliminary local evaluation of ocular motility/alignment must be accomplished by a qualified ophthalmologist or optometrist as described in 6.2.

#### **9.0. Cardiopulmonary System.**

- 9.1. Any documented coronary artery disease (CAD), with or without intervention. Any abnormal noninvasive cardiac test, unless complete evaluation reveals no evidence of CAD.
- 9.2. Any abnormal or borderline ECG finding, unless recommended evaluation discloses no disqualifying pathology. See guidelines for disposition of ECG findings in aircrew available at [http://www.brooks.af.mil/web/consult\\_service/ecg/files/ECG\\_Disposition.pdf](http://www.brooks.af.mil/web/consult_service/ecg/files/ECG_Disposition.pdf).
- 9.3. Any dysrhythmia or ectopy associated with hemodynamic symptoms or when symptoms may interfere with the satisfactory performance of UAS duties. Major dysrhythmias without hemodynamic symptoms. Ablation of major dysrhythmias or bypass tracts.
- 9.4. Symptomatic valvular heart disease. Asymptomatic valvular heart disease graded as moderate or worse.

9.5. Hypertension or history of hypertension on antihypertensive medication. Hypertension is evidenced by average systolic blood pressure greater than 140 mm Hg or average diastolic blood pressure greater than 90 mm Hg.

**NOTE:** Asymptomatic personnel with average systolic blood pressure ranging from 141 mm Hg and 160 mm Hg, or average diastolic blood pressure ranging between 91 mm Hg and 100 mm Hg, may remain on UAS controlling status for up to 6 months (from the time the elevated blood pressure was first identified) while undergoing non-pharmacological intervention to achieve acceptable values.

9.6. Corrected patent ductus arteriosus (PDA), atrial (ASD) and ventricular (VSD) septal defects, and aortic coarctation waiver eligible if no residua. Hemodynamically insignificant ASD and VSD may be acceptable.

9.7. Current or history of any vascular thrombosis or pulmonary embolus.

#### **10.0. Blood and Blood-Forming Tissues**

10.1. Blood donation and immunotherapy: 4 hr restriction from UAS controller duty (formal flight surgeon restriction not required).

#### **11.0. Abdomen and Gastrointestinal System.**

11.1. Acute, recurrent, or chronic cholecystitis.

11.2. Acute or chronic hepatitis or sequelae of chronic liver disease.

11.3. Current or history of peptic, duodenal or gastric ulcer or gastrointestinal bleeding.

11.4. Abnormalities of the bowel including, but not limited to, irritable bowel syndrome, diverticular disease, malabsorption syndromes, or chronic diarrhea of sufficient severity to require frequent interventions or to interfere with normal functioning.

11.5. Current fecal incontinence.

#### **12.0. Female Genital and Reproductive Organs.**

12.1. Current or history of genital infection or ulceration of sufficient severity to require frequent intervention and interferes with normal functioning.

12.2. Current or history of dysmenorrhea that is incapacitating to a degree recurrently necessitating absences of more than a few hours from routine activities.

12.3. Current or history of endometriosis, ovarian cysts, or chronic pelvic pain when symptoms are severe and interfere with normal functioning.

12.4. Current pelvic inflammatory disease.

12.5. Any traumatic, organic, or congenital disorders of the genitalia of sufficient severity to cause distracting symptoms, require frequent intervention, or interfere with normal functioning.

12.6. Pregnancy is not necessarily disqualifying from UAS duties. It may be appropriate to remove an individual from UAS duties if she is experiencing any significant side effects from her pregnancy.

#### **13.0. Male Genitalia.**

- 13.1. Current or history of genital infection or ulceration of sufficient severity to require frequent intervention and interferes with normal functioning.
- 13.2. Current hydrocele, unless small and asymptomatic.
- 13.3. Large or painful left varicocele. Any right varicocele unless significant underlying pathology has been excluded.
- 13.4. Current acute or chronic orchitis or epididymitis if causing severe symptoms or interferes with normal function.
- 13.5. Current or history of chronic scrotal pain.
- 13.6. Chronic prostatitis or prostatic hypertrophy with urinary retention or abscess of the prostate gland.
- 13.7. Any traumatic, organic, or congenital disorders of the genitalia of sufficient severity to cause distracting symptoms, require frequent intervention, or interfere with normal functioning.

#### **14.0. Urinary System.**

- 14.1. Acute, recurrent, or chronic urinary tract diseases causing severe symptoms or interfering with normal function, including, but not limited to urethritis and cystitis.
- 14.2. Current incontinence of urine.
- 14.3. Current urethral stricture, fistula, or cystostomy.
- 14.4. Current hematuria, pyuria, proteinuria (greater than 200 mg/24 hrs; or a protein to creatinine ratio greater than 0.2 in a random urine sample, if greater than 48 hours after strenuous activity), or other findings indicative of urinary tract disease unless consultation determines the condition to be benign.
- 14.5. Current urolithiasis or history of recurrent calculus, nephrocalcinosis, retained extraparenchymal calculus, or bilateral renal calculi.
  - 14.5.1. Uncomplicated single episode of renal calculus does not require waiver, but should be evaluated.
- 14.6. Renal ptosis (floating kidney) causing impaired renal drainage or pain.
- 14.7. Current or history of horseshoe kidney.
- 14.8. Current neurogenic bladder.
- 14.9. History of renal transplant.
- 14.10. Any traumatic, organic, or congenital disorders of the urinary tract of sufficient severity to cause distracting symptoms, require frequent intervention, or interfere with normal functioning.

#### **15.0. Endocrine.**

- 15.1. Current or history of adrenal, pituitary, parathyroid, thyroid, or nutritional disease unless asymptomatic, the underlying condition has been corrected, and there are no residua.

15.2. Current or history of gout.

15.3. Diabetes mellitus. (See note at AFI48-123V2 Attachment 2.17.5 for diagnostic criteria).

## **16.0. Neurological Disorders.**

16.1. History of any disturbance of consciousness (not due to head injury).

16.1.1. An isolated episode of neurocardiac syncope associated with venipuncture or similar benign precipitating event which is less than 1 minute in duration, without loss of continence, and followed by rapid and complete recovery without sequelae does not require waiver if a thorough neurological and cardiovascular evaluation by a flight surgeon reveals no abnormalities.

16.2. History of head injury is managed as per AFI48-123V3 Attachment 4.24.1.6 and AFI48-123V4 Section 1.2.3.

16.3. Seizures of any type.

16.3.1. Electroencephalographic abnormalities.

16.3.1.1. Truly epileptiform abnormalities to include generalized, lateralized, or focal spikes, sharp waves, spike-wave complexes, and sharp and slow wave complexes during alertness, drowsiness, or sleep are disqualifying. Benign transients such as Small Sharp Spikes (SSS) or Benign Epileptiform Transients (BETS), wicket spikes, 6 Hz (phantom spike and wave, rhythmic temporal theta of drowsiness (psychomotor variant), and 14 and 6 Hz positive spikes are not disqualifying.

16.3.1.2. Generalized, lateralized, or focal continuous polymorphic delta activity or intermittent rhythmic delta activity during alert state is disqualifying, unless the etiology of the abnormality has been identified and determined not to be a disqualifying condition.

16.4. Current or history of any of the following types of headaches:

16.4.1. Recurrent primary headaches, including, but not limited to migraine, tension-type, and cluster headaches with any of the following characteristics:

16.4.1.1. Impairment in social, vocational or academic activities caused by the headache, its associated symptoms, or both.

16.4.1.2. Medication other than over-the-counter analgesics is required for abortive control of the headache.

16.4.1.3. A prescription for prophylactic medication is required to control the headache.

16.4.1.4. There is neurological dysfunction or deficit including aura, with or without (e.g., acephalgic migraine) associated headache.

16.4.2. A secondary headache meeting any of the above criteria unless both the headache and its underlying cause(s) have resolved.

16.5. Current or history of vertigo or disequilibrium disorders.

16.6. Current or history of cerebrovascular conditions, including, but not limited to subarachnoid or intracerebral hemorrhage, vascular insufficiency, aneurysm, arteriovenous malformation, or cerebrovascular infarct.

16.7. Current or history of acute infectious process of the central nervous system or neurosyphilis of any form.

16.8. Current or history of paralysis, weakness, lack of coordination, chronic pain, or sensory disturbance.

16.9. Chronic nervous system disorders, including, but not limited to demyelinating, autoimmune, extrapyramidal, hereditary, and degenerative diseases.

16.10. Sleep disorders to include, but not limited to, sleep apneas, insomnias, hypersomnias, narcolepsy, or restless leg syndrome.

**17.0. Learning, Psychiatric, and Behavioral.** (Reference current edition of the *Diagnostic and Statistical Manual of Mental Disorders*, American Psychiatric Association)

17.1. Attention Deficit Disorder/Attention Deficit Hyperactivity Disorder or Perceptual/Learning Disorder(s), unless the individual can demonstrate passing academic performance and there has been no use of medication(s) in the past 12 months.

17.2. History of persistent learning disorder.

17.3. Current or history of eating disorder.

17.4. Current or history of alcohol dependence, drug dependence, alcohol abuse, drug abuse, or any other substance-related disorders. Alcohol dependence and abuse may be waived in accordance with the requirements in AFI48-123V3 Attachment 4.25.1.5.

17.5. Current or history of schizophrenia or other psychotic disorder.

17.6. Current or history of mood disorder including, but not limited to, major depressive disorder, dysthymic disorder, cyclothymic disorder, depressive disorder not otherwise specified, and bipolar disorder.

17.7. Current or history of anxiety disorder including, but not limited to, generalized anxiety disorder, phobic disorders, obsessive-compulsive disorder, posttraumatic stress disorder, and acute stress disorder.

17.8. Current or history of dissociative disorder.

17.9. Current or history of somatoform disorders including, but not limited to, hypochondriasis or pain disorder.

17.10. Gender identity disorder.

17.11. Sexual dysfunctions and sexual disorders not otherwise specified are not medically disqualifying unless in association with another Axis I disorder.

17.12. Sexual paraphilias are not medically disqualifying; however, individuals meeting diagnostic criteria are dealt with administratively.

17.13. Current adjustment disorder of more than 60 days duration.

17.14. Psychological factors affecting a medical condition.



- 17.15. Mental disorder due to a general medical condition.
- 17.16. Current or history of delirium, dementia, amnestic, and other cognitive disorder.
- 17.17. Sleep disorders of such magnitude to warrant somatic treatment greater than 30 days duration, or if associated with an Axis I disorder other than adjustment disorder.
- 17.18. Current or history of factitious disorder.
- 17.19. Current or history of impulse control disorder.
- 17.20. Unsatisfactory adaptability rating for UAS duties (AR-UAS). Maladaptive personality traits (not meeting diagnostic criteria for a personality disorder), or a pattern of maladaptive behavior that significantly interferes with safe UAS operation, crew coordination, or mission completion. In the absence of maladaptive personality traits or behavior patterns, motivational issues are managed administratively.
- 17.21. Personality disorder severe enough to repeatedly manifest itself by significant interference with safe UAS operation, crew coordination, or mission completion; but cannot be used as a medical reason for separation from active duty.
- 17.22. History of suicidal behavior including gesture(s) or attempt(s), or history of self-mutilation.
- 17.23. Current or history of a mental disorder that, in the opinion of the flight surgeon, shall interfere with, or prevent satisfactory performance of military duties.

#### **18.0. Spine and Musculoskeletal.**

- 18.1. Current conditions including, but not limited to, the spine and sacroiliac joints associated with local or referred pain to the extremities, muscular spasms, postural deformities, requires external support, requires frequent treatment, or prevents satisfactory performance of duties.
- 18.2. Current disease, injury, or congenital condition with residual weakness or symptoms such as to require frequent treatment or prevent satisfactory performance of duties including, but not limited to, chronic joint pain and late effect of fractures, and tendon injuries.

#### **19.0. Additional Testing.**

- 19.1. HIV antibody and RPR testing is required for all applicants for initial duty.
- 19.2. An AR-UAS and a reading aloud test (RAT) are required for all applicants for initial duty.

#### **20.0. Medication.**

- 20.1. Use of any medication, except as described in the "Official Air Force Approved Aircrew - Quick Reference List" (approved by AF/SGOP).

#### **21.0. Miscellaneous.**

- 21.1. Malignancies. History or presence of malignant tumor, cyst, or cancer of any sort. Basal cell and squamous cell carcinomas and carcinoma-in-situ of the cervix which have been adequately excised (as evidenced by pathology report, or basal cell carcinoma which have been treated with electrodesiccation and curettage by a dermatologist credentialed to

perform this procedure) are not disqualifying. Childhood malignancy considered cured may be considered for waiver on a case-by-case basis.

21.2. Benign tumors which interfere with function, are likely to enlarge or be subjected to trauma during military service, or shown malignant potential.

21.3. Other congenital or acquired abnormalities, defects, or diseases which preclude safe and satisfactory performance of UAS duties.

## CONCLUSION

Perhaps the most significant finding of this study was the unanimous agreement among USAF aerospace medicine experts that current standards for flying duties (AFI48-123V3 Attachment 4) are unnecessarily restrictive when applied to the unmanned aircraft domain. Although many of the job essential tasks of the UAS pilot and manned pilot are the same, the work environments in which these tasks must be executed fundamentally differ. An equally significant finding was that medical standards for ground-based controller duty (AFI48-123V3 Attachment 2) are lacking when applied to pilots of large or weaponized UASs. In this case, although there are similarities in the work environments, the job essential tasks are very different. Additionally, concerns regarding the potential for subtle decrements in performance, distraction, or sudden incapacitation are more significant for the UAS pilot vice the air traffic control specialist. The latter's role is ultimately advisory rather than mandatory as legal responsibility for attending to an aircraft always rests with the pilot (Hopkins, 1970).

The recommended medical standards for UAS pilots place increased emphasis on visual, cardiac, neurological, and psychiatric factors relative to the medical standards for ground-based controller duties. Given these areas of increased emphasis, the current USAF medical flight screening (MFS) program would be applicable in the initial selection of candidates for UAS pilot training, particularly if they must also meet FC I medical standards prior to attending IFS. The panel of aerospace medicine specialists concluded the anthropometric, neuropsychiatric, and ophthalmologic elements of MFS would be applicable to UAS pilot applicants, but the echocardiography evaluation could be excluded. Since the recommended ophthalmologic standards for UAS pilots do not differ markedly from those for manned aircraft pilots, the current MFS ophthalmologic testing should be equally appropriate for UAS pilots. With regards to anthropometric screening, while it is possible to engineer the GCS to accommodate a larger percentage of the population than can be done with traditional cockpits, such accommodation comes at increased expense and with potential tradeoffs against other desirable design elements. These issues make an up-to-date anthropometric database of the actual population of USAF UAS pilots very important for GCS designers and UAS acquisitions personnel. Finally, the availability of baseline neuropsychiatric testing would be invaluable in informing future aeromedical waiver decisions for UAS pilots, for example by potentially decreasing the duration of the prescribed observation period following a head injury. Additionally, some have speculated that neuropsychiatric measures have potential utility in optimizing UAS pilot selection and training (Dolgin, Hay, Wasel, & Hoffman, 1999). Policy decisions regarding the utilization of such neuropsychiatric measures for UAS pilot selection will require large datasets which have been correlated with subsequent performance metrics. Thus, if future inroads are to

be made into UAS pilot selection, it is imperative to start collecting the necessary data now in coordination with performance assessments in the training and operational environments.

Although it is outside the scope of this study, the issue of UAS sensor operator medical standards warrants comment for future evaluation. North Atlantic Treaty Organization (NATO) Standardization Agreement (STANAG) 4586 defines five levels of unmanned aircraft control (Figure 2), with several current and projected UASs allowing sensor operators some degree of level 4 control. A recent USAF MQ-1 Predator sensor operator task analysis evaluated sensor operator job tasks in both the single aircraft and MAC GCSs. As shown in figure 3, the implementation of MAC has resulted in the sensor operator's job task set being significantly modified to now include tasks once reserved solely for pilots. Currently, medical standards for ground-based controller duties (AFI48-123V3 Attachment 2) are inclusive of the standards for sensor operators. At a minimum, the applicability of these standards should be re-evaluated given the changes in the sensor operator task environment. Another option may be to utilize a stratified approach, certifying sensor operators IAW AFI48-123V3 Attachment 2, but requiring sensor operators engaged in MAC operations to meet UAS pilot standards.

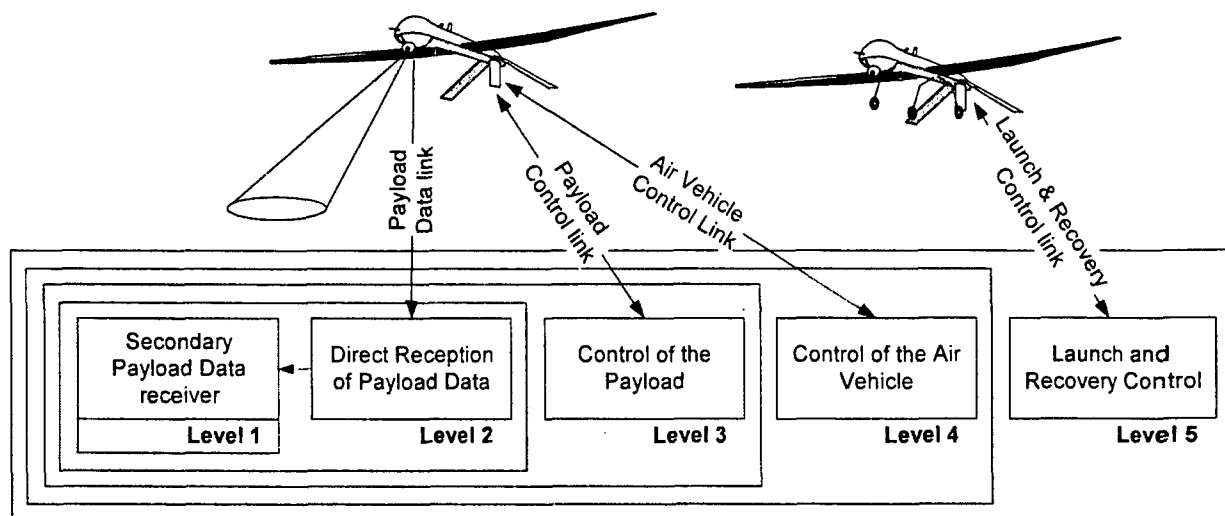


Figure 2. NATO STANAG 4586 levels of UAS interoperability.

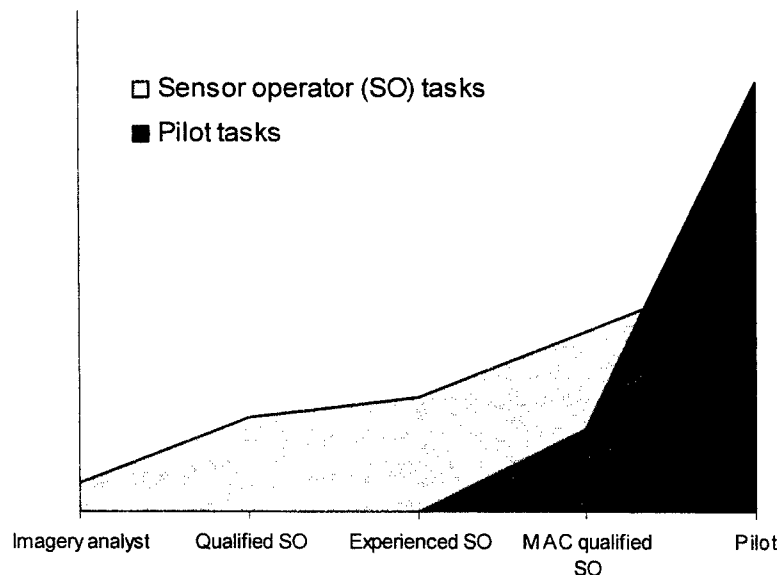


Figure 3. Notional graph showing the trend for sensor operator duties to encroach upon pilot tasks as their mission participation and responsibilities increase in the multi-aircraft control (MAC) environment.

In closing, the methodology employed in the present study offers a significant advantage over other approaches to establishing UAS pilot medical standards. By not trying to conform to an existing set of medical standards, the proposed UAS pilot medical standards are not a compromise, but rather accurately reflect the specific aeromedical concerns of the unmanned aircraft occupational domain. Also, in starting from a UAS pilot task analysis, the proposed medical standards address known occupational factors rather than speculative concerns. However, the fact these medical standards were developed from a study of large, weaponized UASs necessarily calls into question their generalizability to small, unarmed UASs. Nevertheless, this study provides an important piece of information for USAF leaders as they attempt to make evidence-based decisions when dealing with the contentious issues surrounding certification of UAS operations and accessing the national air space.

## REFERENCES

- Biggerstaff, S., Blower, D. J., Portman, C.A., & Chapman, A. D. (1998). *The development and initial validation of the unmanned aerial vehicle (UAV) external pilot selection system* (NAMRL-1398). Pensacola, FL: Naval Aerospace Medical Research Laboratory.
- Cooke, N. J., Pringle, H., Pedersen, H., Connor, O., & Salas, E. (Eds.) (2006). *Human factors of remotely operated vehicles*. Volume 7 in *Advances in Human Performance and Cognitive Engineering Research Series*. Amsterdam: Elsevier.
- Dolgin, D., Hay, G., Wasel, B., & Hoffman, C. (1999). *Identification of the cognitive, psychomotor, and psychosocial skill demands of uninhabited aerial vehicle (UCAV) operators*. Retrieved February 7, 2005, from the Navy Operational Medicine Institute Web site: <http://forum.nomi.med.navy.mil/articles/safeucav/index.htm>
- Hopkins, V. D. (1970). *Human factors in the ground control of aircraft* (AGARD-AG-142). Neuilly-sur-Seine, France: North Atlantic Treaty Organization.
- Tvaryanas, A. P. (In press). Human systems integration in remotely piloted aircraft operations. *Aviation, Space, and Environmental Medicine*.
- Weeks, J. L. (2000). *Unmanned aerial vehicle operator qualifications* (AFRL-HE-AZ-TR-2000-0002). Mesa, AZ: Air Force Research Laboratory.
- Williams, K. W. (2005). *Unmanned aircraft pilot medical and certification requirements*. Retrieved September 17, 2006, from Federal Aviation Administration Web site: <http://www.hf.faa.gov/docs/508/docs/gaFY05UAVtrain.pdf>

## APPENDIX A - UAS DESCRIPTIONS

### MQ-1 Predator

**Manufacturer:** General Atomics Aeronautical Systems Inc.

**Inventory:** 120+ (All types) Delivered/77 Planned

**Background:** The MQ-1 Predator is a medium-altitude, long-endurance, unmanned aircraft system. The MQ-1's primary mission is interdiction and conducting armed reconnaissance against critical, perishable targets. The basic crew for the Predator is one pilot and one sensor operator. The MQ-1 Predator was one of the initial Advanced Concept Technology Demonstrations (ACTDs) in 1994 and transitioned to an Air Force program in 1997. Since 1995, Predator has flown surveillance missions over Iraq, Bosnia, Kosovo, and Afghanistan. In 2001, the Air Force demonstrated the ability to employ Hellfire missiles from the Predator, leading to its designation being changed from the RQ-1 to MQ-1 to reflect its multi-mission capability. The Air Force operates 12 systems in three Predator squadrons. The MQ-1 fleet reached the 100,000 flight hour mark in October 2004, and was declared operationally capable in March 2005. In early 2006, the prototype multi-aircraft control (MAC) ground control station was fielded, providing the capability for 1-2 pilots and four sensor operators to control up to four aircraft.

**Characteristics:**

Length: 26.7 ft

Wing span: 48.7 ft

Gross weight: 2,250 lb

Payload capacity: 450 lb

Engine make: Rotax 914F

Power: 115 hp

Endurance: 24+ hr/clean, 14 hr/external stores

Max/loiter speeds: 118/70 kt

Ceiling: 25,000 ft

Radius: 500 nm

Sensors: EO/IR, SAR

Weapons: Two AGM-114 Hellfire missiles



### MQ-9 Reaper

**Manufacturer:** General Atomics Aeronautical Systems Inc.

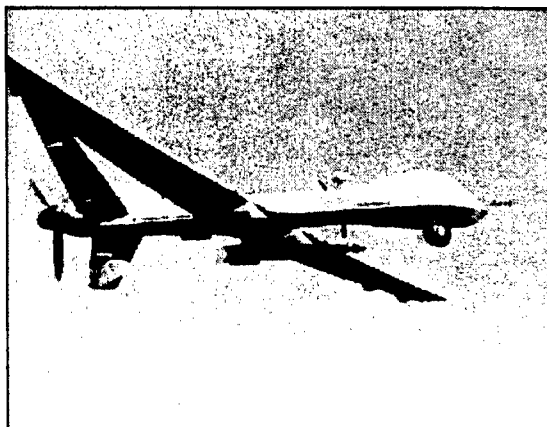
**Inventory:** 6 Delivered/60 Planned

**Background:** The MQ-9 is a medium-to-high altitude, long-endurance unmanned aircraft system. Its primary mission is as a persistent hunter-killer for critical time sensitive targets and secondarily to act as an intelligence collection asset. The crew for the MQ-9 is one pilot and one sensor operator. The USAF proposed the MQ-9 system in response to the Department of Defense request for Global War on Terrorism (GWOT) initiatives in October 2001. In June

2003, Air Combat Command (ACC) approved the MQ-9 Concept of Operations. The objective force structure includes nine combat-coded systems and 36 aircraft.

**Characteristics:**

Length: 36 ft  
Wing span: 66 ft  
Gross weight: 10,500 lb  
Payload capacity: 750 lb  
Engine make: Honeywell TPE 331-10  
Power: 900 shp  
Endurance: 30 hr/clean, 16-20 hr/external stores  
Max/loiter speeds: 225/TBD kt  
Ceiling: 50,000 ft  
Radius: 2,000 nm  
Sensors: EO/IR, SAR/MTI  
Weapons: Four, 500 lb class or 8-10, 250 lb class



**RQ-4 Global Hawk**

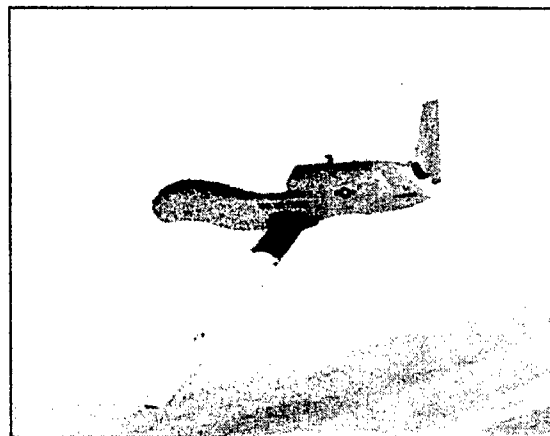
**Manufacturer:** Northrop Grumman

**Inventory:** 12 Delivered/58 Planned (7 ACTD + 51 Production aircraft)

**Background:** The Air Force RQ-4 Global Hawk is a high-altitude, long-endurance unmanned aircraft designed to provide wide area coverage of up to 40,000 nm<sup>2</sup> per day. The RQ-4A RQ-4B (Blocks 20, 30, 40) models are larger than the RQ-4A (Block 10) model. Global Hawk completed its first flight in February 1998 and transitioned from an ACTD into engineering and manufacturing development in March 2001. Global Hawk carries both an EO/IR sensor and a SAR/MTI capability, allowing day/night, all-weather reconnaissance. The Air Force has budgeted for 34 production aircraft in FY05-10, and plans a total fleet of 51 aircraft. The first of 44 "B" models is to be available for flight test in November 2006. The first Multi-Int payload which includes Advanced Signals Intelligence Program (ASIP) will be available for flight test in May 2007 followed by Multi-Platform Radar Technology Insertion Program (MP-RTIP) payload in July 2007.

**Characteristics:**

Length: 44.4-47.6 ft  
Wing span: 116.2-130.9 ft  
Gross weight: 26,750-32,250 lb  
Payload capacity: 1,950-3,000 lb  
Engine make: Rolls Royce AE-3007H  
Power: 7,600 lb (SLS)  
Endurance: 28-32 hr  
Max/loiter speeds: 340-350/310-340 kt  
Ceiling: 60,000-65,000 ft  
Radius: 5,400 nm  
Sensors: EO/IR, SAR/MTI, SIGINT



## APPENDIX B – ACRONYMS

ACC	Air Combat Command
ACTD	Advanced Concept Technology Demonstration
AFI	Air Force Instruction
AFMOA	Air Force Medical Operations Agency
AFPAM	Air Force Pamphlet
AFSC	Air Force Specialty Code
AR-UAS	Adaptability Rating – Unmanned Aircraft System
ASD	Atrial Septal Defect
ASIP	Advanced Signals Intelligence Program
BETS	Benign Epileptiform Transients
CAD	Coronary Artery Disease
CTT	Color Threshold Tester
dB	Decibels
DTIC	Defense Technical Information Center
EEI	Essential Elements of Information
EO/IR	Electro-Optical/Infra Red
FAA	Federal Aviation Administration
FALANT	Farnsworth Lantern Test
GCS	Ground Control Station
GWOT	Global War on Terrorism
HL	Hearing Level
Hz	Hertz
IAW	In Accordance With
IFS	Initial Flight Screening
LOC	Loss of Consciousness
LRE	Launch and Recovery Element
MA	Major Accomplishment
MAC	Multi-aircraft Control
MAJCOM	Major Command
MCE	Mission Control Element
MFS	Medical Flight Screening
mm Hg	Millimeters of Mercury
MP-RTIP	Multi-Platform Radar Technology Insertion Program
MRI	Magnetic Resonance Imaging
MTI	Moving Target Indicator
NATO	North Atlantic Treaty Organization
NPP FEA	New Performance Planning Front End Analysis
NTIS	National Technical Information Services
OU	Oculus Uterque (either eye, each eye)
OVT	Optec Vision Tester
PDA	Patent Ductus Arteriosus
PIP	Pseudo-Isochromatic Plate
PRK	Photorefractive Keratectomy



RAT	Read Aloud Test
RS	Reconnaissance Squadron
SAR	Synthetic Aperture Radar
SIGINT	Signals Intelligence
SLS	Sea Level Standard
SME	Subject Matter Expert
SSS	Small Sharp Spikes
STANAG	Standardization Agreement
SURVIAC	Survivability and Vulnerability Analysis Center
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
URT	Undergraduate Remotely Piloted Aircraft Training
USAF	United States Air Force
VSD	Ventricular Septal Defect
VTA-DP	Vision Test Apparatus – Depth Perception